# 2012 Smart Grid Program Peer Review Meeting

## SDG&E Borrego Springs Microgrid Demonstration Project

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Principal Investigator

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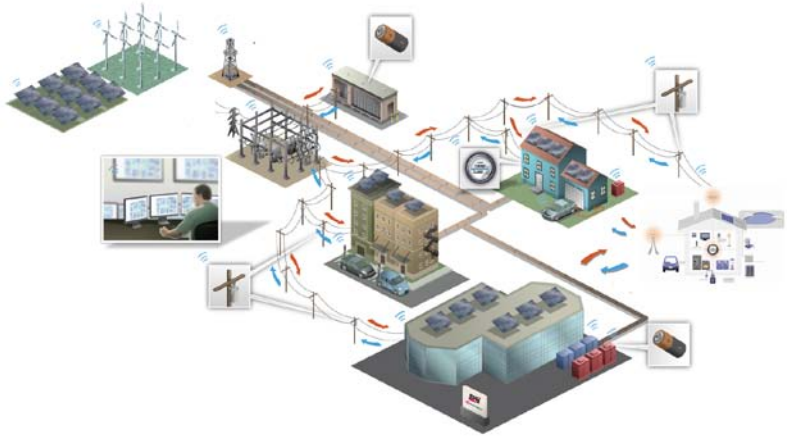
# Borrego Springs Microgrid Demonstration Project

## Objective

Conduct a pilot scale “proof-of concept” demonstration of how advanced information-based technologies and distributed energy resources (DER) may increase asset utilization and reliability of the power grid in support of the national agenda.



## Life-cycle Funding ($K)

| Budget Period 1 FY2008 – FY2010 | Budget Period 2 FY2011 – FY2013 | Total DOE Funding |
|---|---|---|
| $1,241 | $6,237 | **$7,477** |

## Technical Scope

Establish a microgrid demonstration to prove the effectiveness of integrating multiple DER technologies, energy storage, feeder automation system technologies, and outage management systems with advanced controls and communication systems, for the purposes of improving stability and effecting feeder/substation capacity in normal and outage/event conditions,

# What is a microgrid?

**Microgrid Definition:**

*A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. If desired, a microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.*

**Microgrid Key Attributes** (Defining Characteristics):

- Grouping of interconnected loads and distributed energy resources
- Can operate in island mode or grid-connected if desired
- Can connect and disconnect from the grid if desired
- Acts as a single controllable entity to the grid

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# Why are microgrids important?

**Enables Grid Modernization**

- Key component of grid modernization
- Enables integration of multiple Smart Grid technologies

**Enhance the integration of Distributed and Renewable Energy Sources**

- Facilities integration of combined heat and power (CHP)
- Promotes energy efficiency and reduces losses by locating generation near demand
- Potential to reduce large capital investments by meeting increased consumption with locally generated power. (Local generation lowers investment in the macrogrid)
- Encourages third-party investment in the local grid and power supply
- Potential to reduce peak load

**Meets End User Needs**

- Ensure energy supply for critical loads
- Power quality and reliability controlled at the local level
- Promotes demand-side management and load leveling
- Promotes community energy independence and allows for community involvement in electricity supply
- Designed to meet local needs and increase customer (end-use) participation

**Supports the Macrogrid**

- Enables a more flexible macrogrid by handling sensitive loads and the variability of renewables locally
- Enhances the integration of distributed and renewable energy resources including CHP
- Potential to supply ancillary services to the bulk power system
- Potential to lower overall carbon footprint by maximizing clean local generation
- Potential to resolve voltage regulation or overload issues

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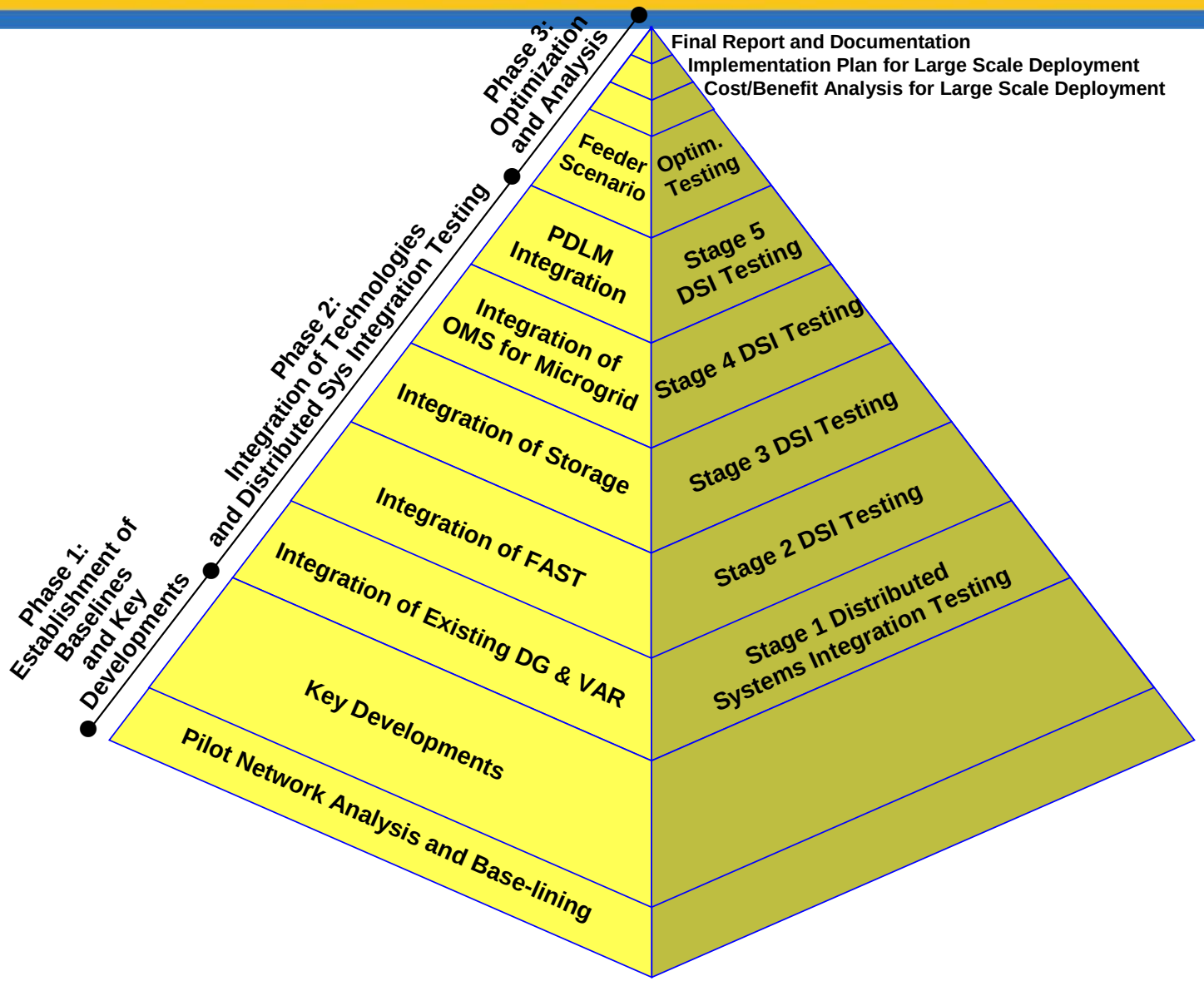
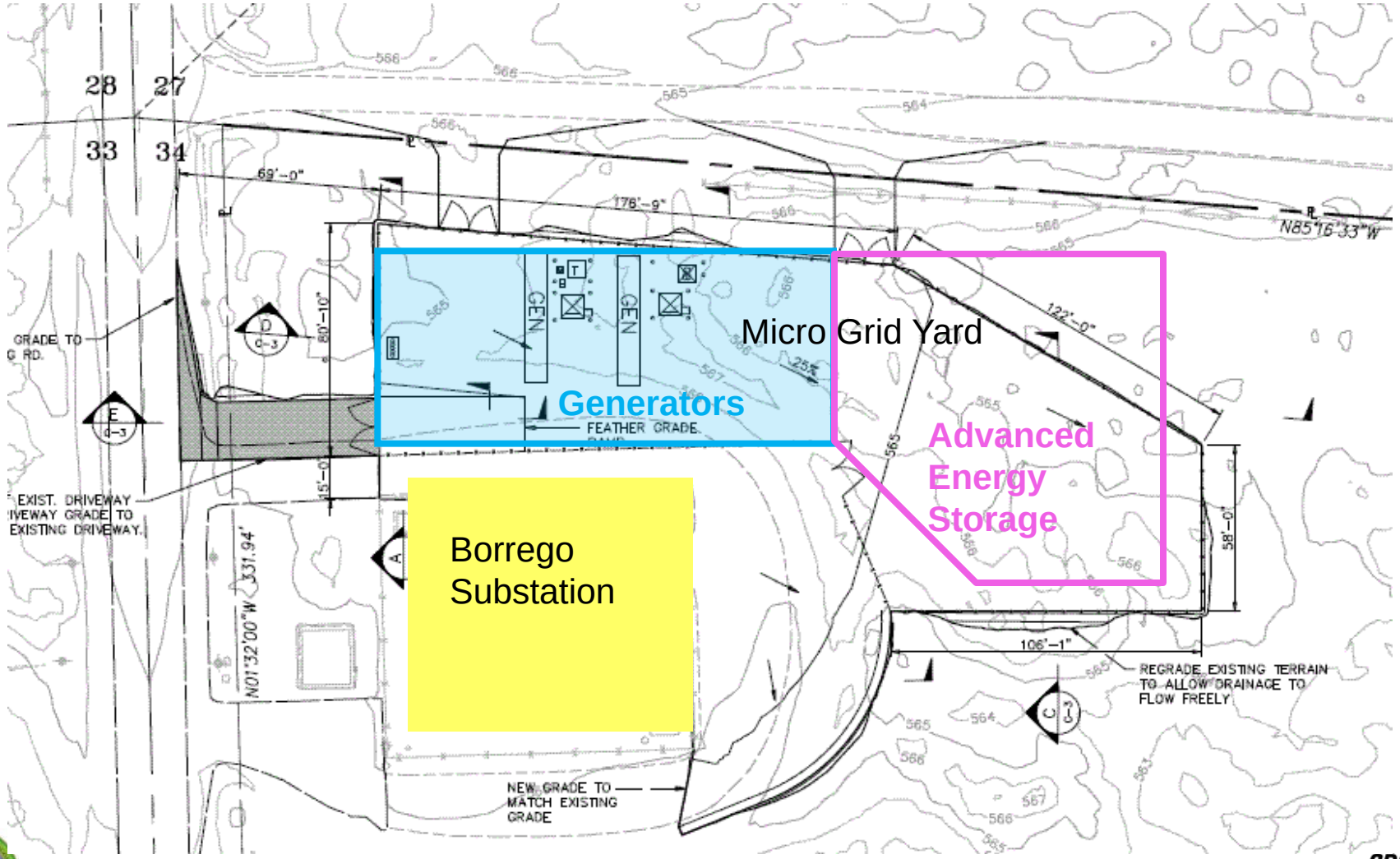
# Technical Approach

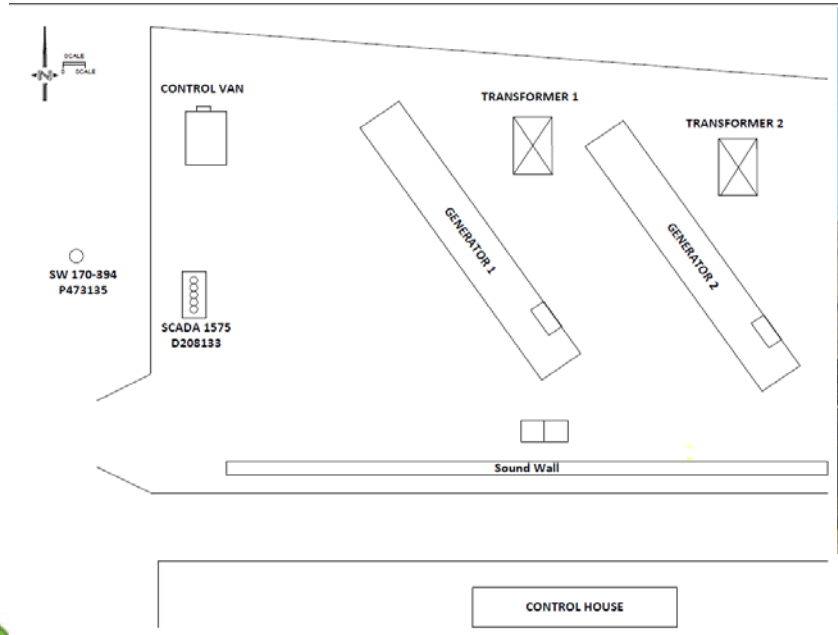


# Microgrid Yard



# DG – Microgrid Yard

- Two (2) 1.8 MW Caterpillar Diesel Generators owned by SDG&E
- Two (2) 12kV Wye/480V Wye pad mount transformers
- 5-Way Trayer SCADA Switch, SS#1575
- Microgrid Control Van




# AES – Microgrid Deployment

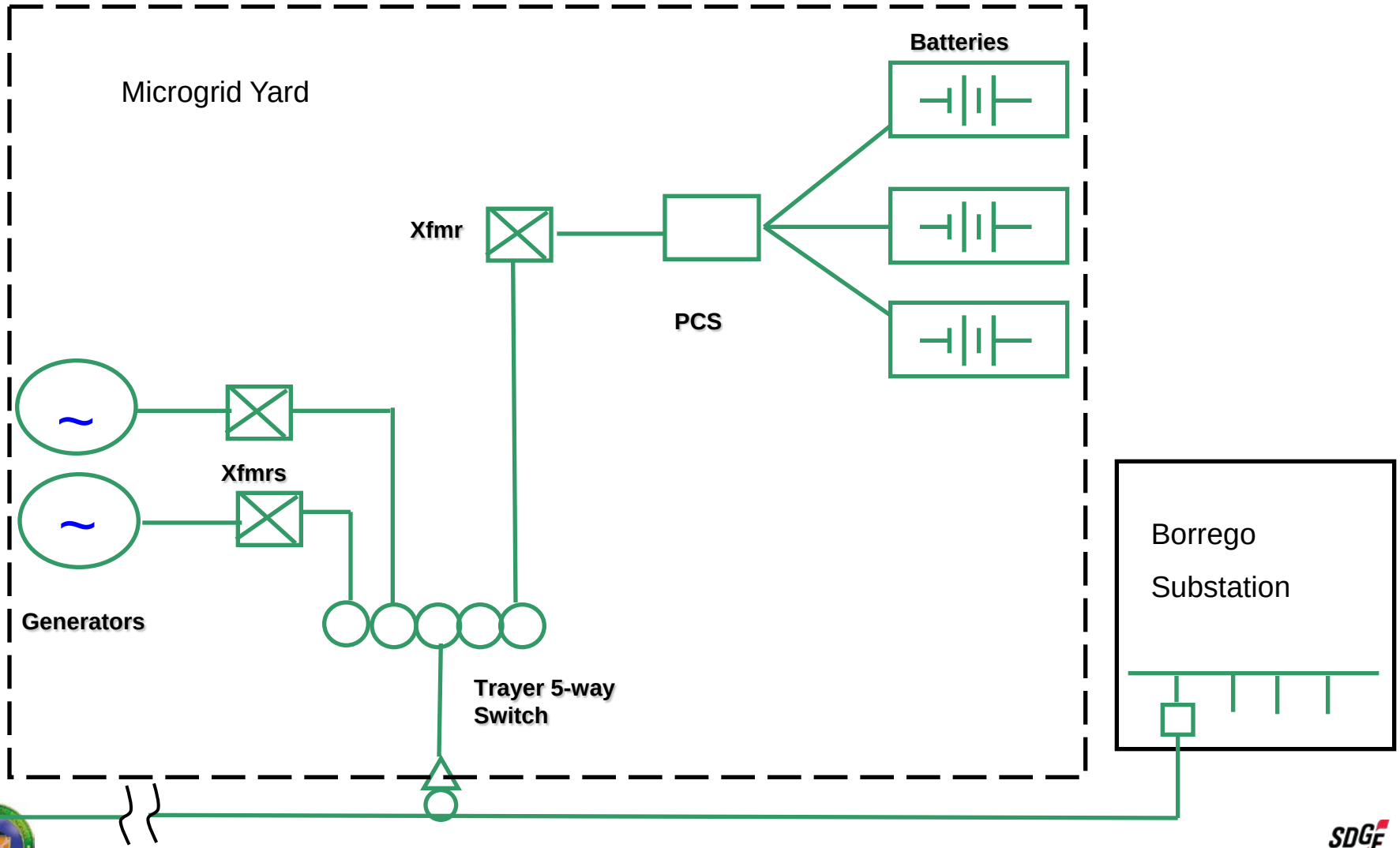
- **Substation Energy Storage (SES)**
  - One 500 kW/1500 kWh battery at Borrego Sub
- **Community Energy Storage (CES)**
  - Three 25 kW/50kWh units on circuit 170
- **Home Energy Storage (HES)**
  - Six  4 kW/8kWh units

# AES – Substation Battery

- Manufacturer: Saft / Parker Hannifin
- One 500 kW/1500 kWh battery at Borrego Sub
- Modes of Operation
    - Peak Shaving/Load Following
    - Renewal Smoothing
    - Support Islanding Operation


*Saft 20 Foot Containerized Battery System*

# Microgrid Yard-
# Generator & Battery Configuration




*Microgrid Circuit*

# AES – Community Energy Storage (CES)

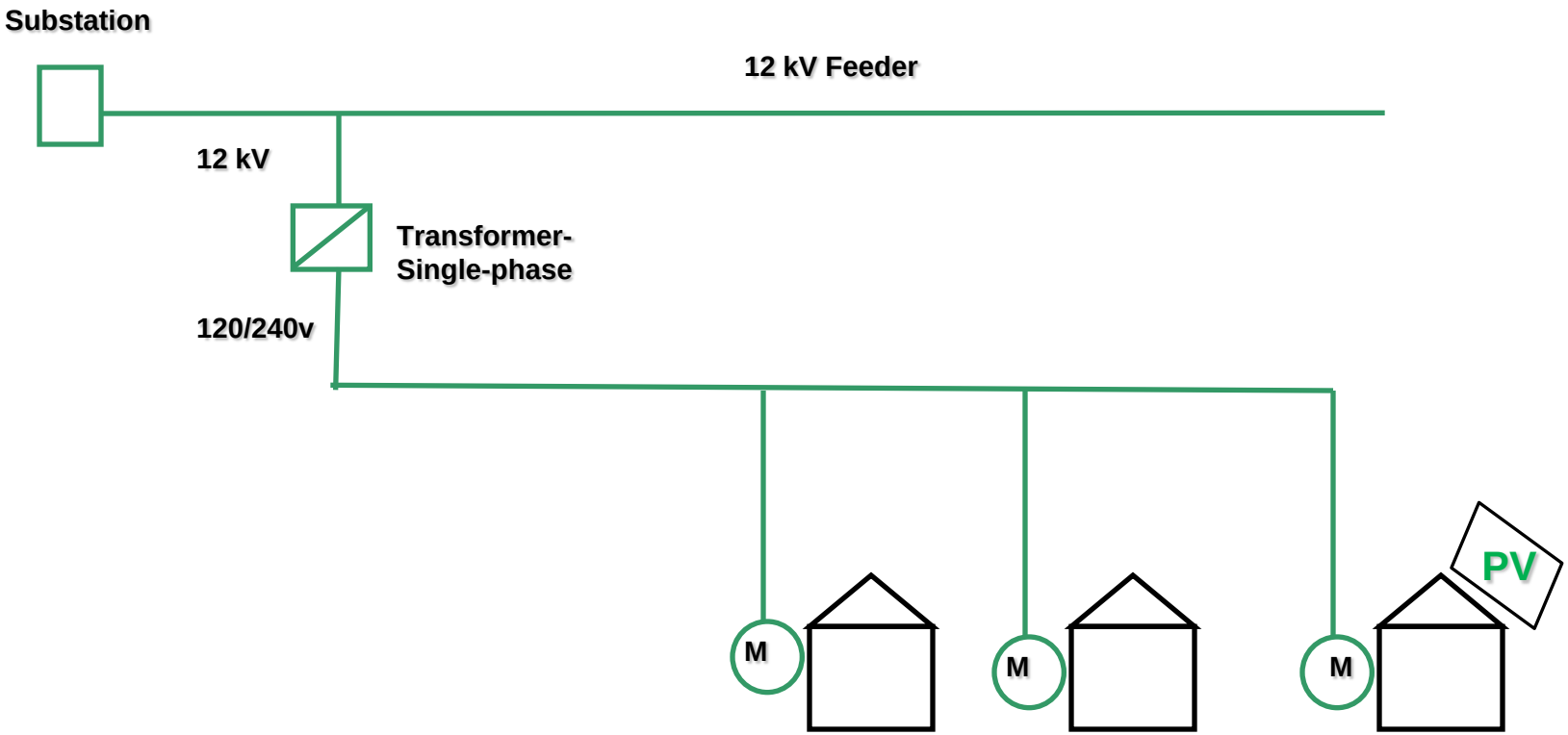
- Manufacturer: S&C / Kokam
- Three 25 kW/50kWh units connected to 12 kV cir 170
  - Operated independently and as a fleet
- Modes of Operation
  - Peak Shaving
  - Renewable Smoothing
  - Voltage Support

Li Ion Battery

Inverter / PCS

Box Pad For Below-Ground Battery

# AES – CES Conceptual One-line



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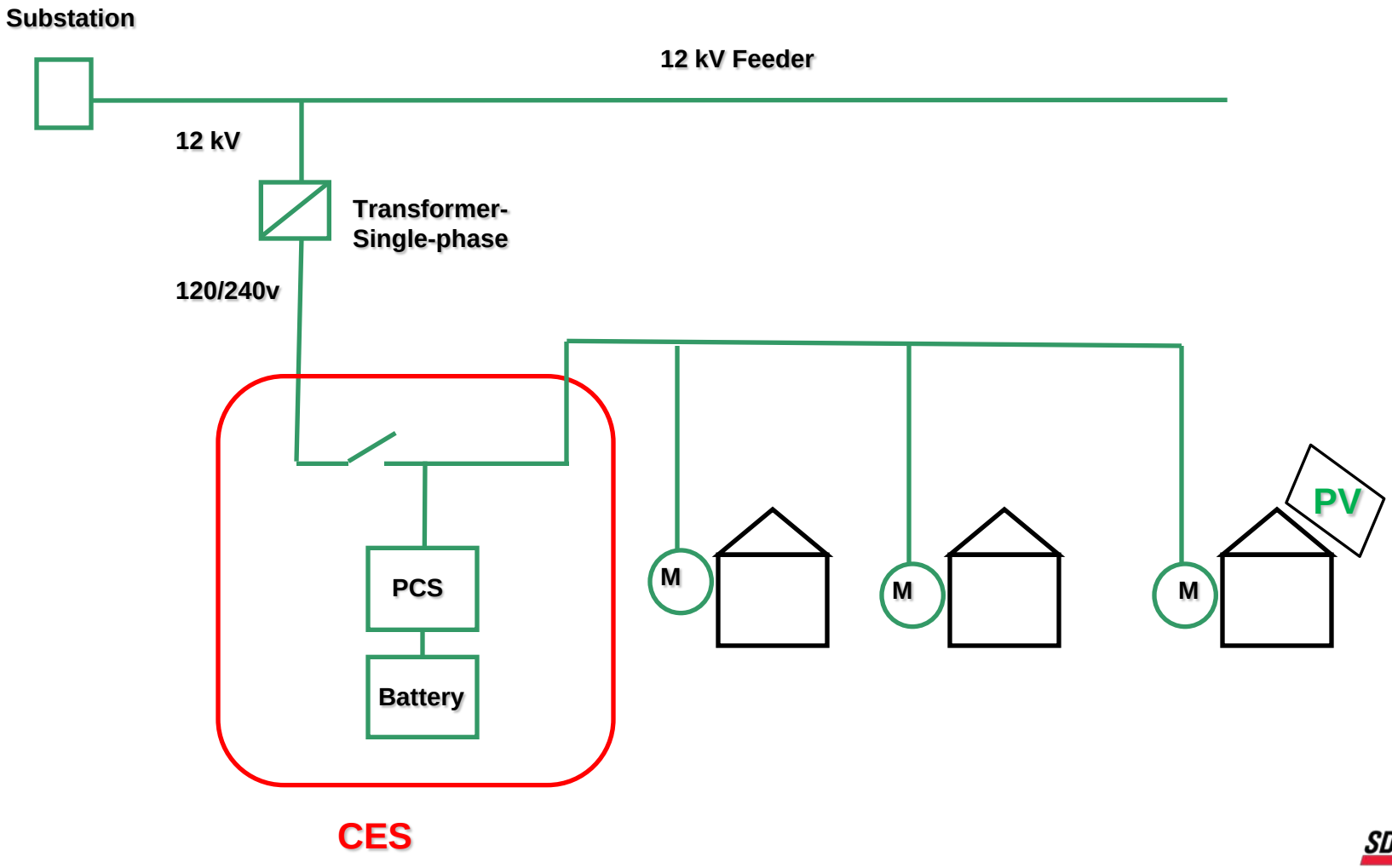
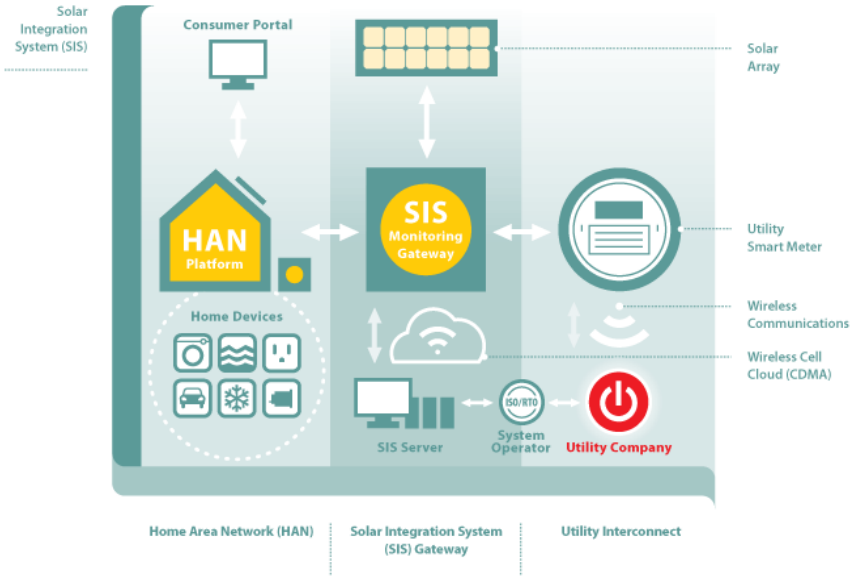


# AES – Home Energy Storage (HES)

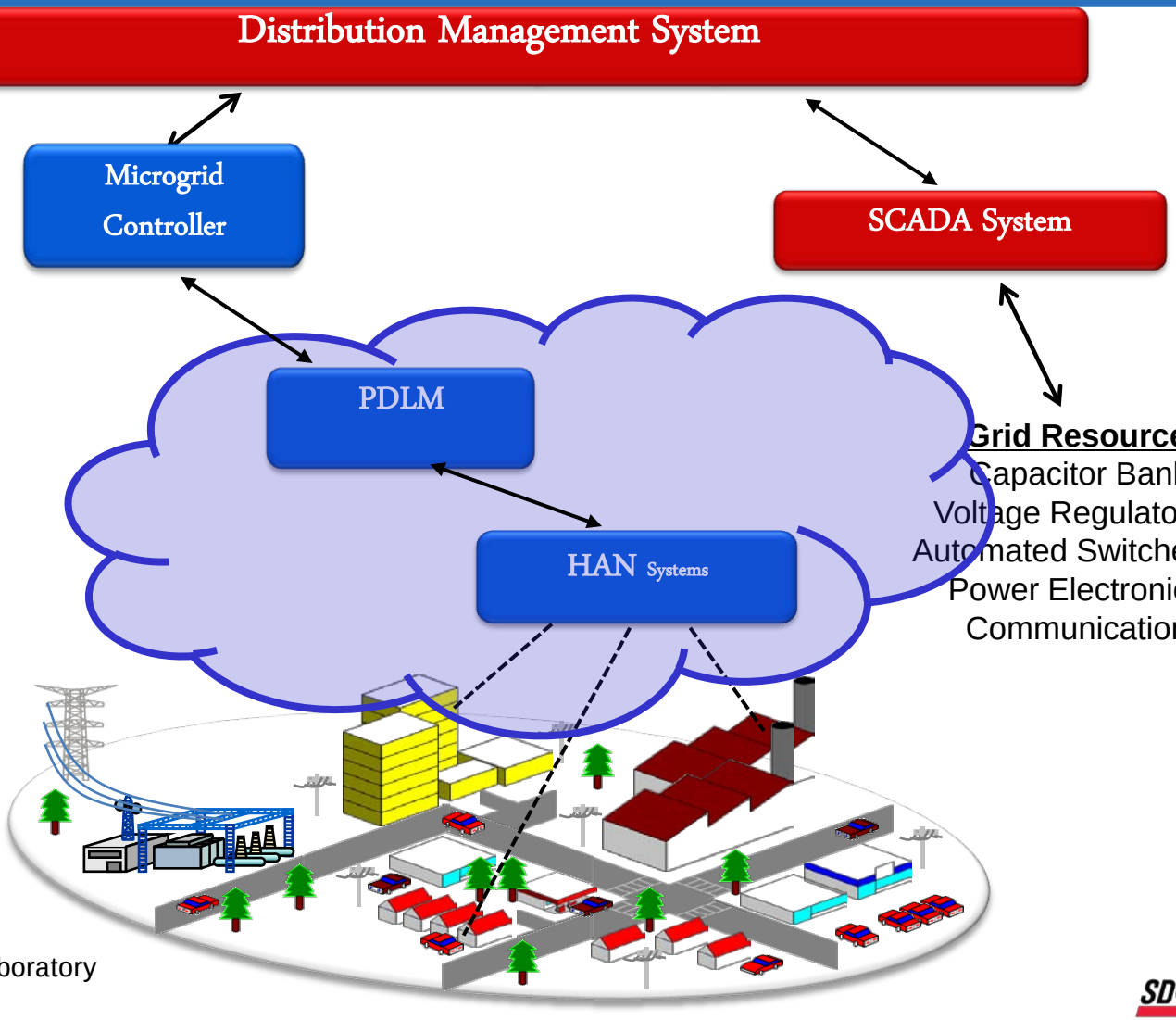
## 4.2 kW Capacity – 2 hours


## Charge/Discharge commands via HAN system



# Price-Driven Load Management





# Home-Area-Networks Capable of Responding to Price and Reliability Events

**Energy Storage**
Devices that maintain reliability of the electric grid by storing energy for use at a later time.

**HVAC**
Communicates with your thermostat to efficiently adjust the temperature based on your home needs.

**SmartMeter**
An advanced meter which communicates via Zigbee© signal with smart devices in the home.

**Smart Appliances**
Appliances that have been modernized to monitor and automatically adjust how they operate according to your preferences.

**Programmable Communicating Thermostat**
A thermostat that connects to your Smart Meter which, based on personal settings, manages your heating and cooling costs.

**Solar Panel**
An array of panels that absorb sunlight to generate electricity for your home.

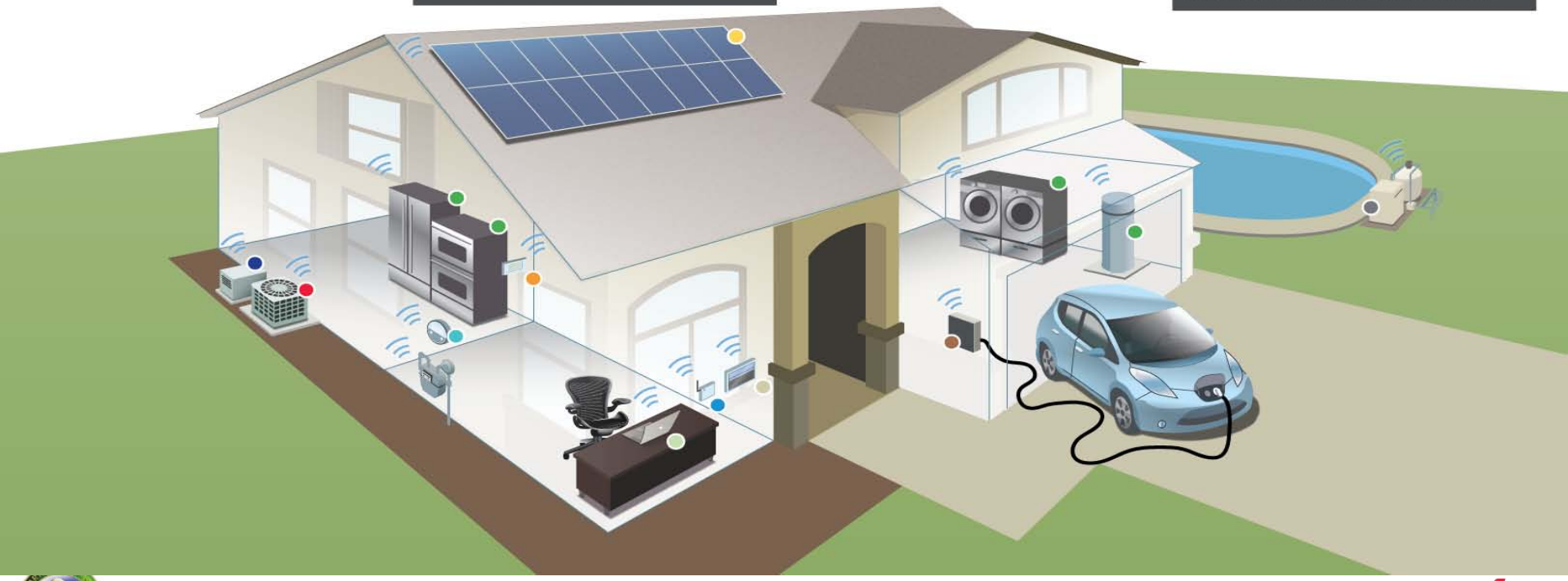
**Interactive User Portal**
An online tool that allows consumers to view and manage their energy consumption in real time from a computer. It works in conjunction with a gateway to receive updates through the internet and allows you to control your smart devices remotely.

**Gateway**
A device that allows Smart Appliances in the consumer's home to communicate with a Smart Meter owned by the utility.

**In Home Energy Display**
A device that connects to a Smart Meter which provides real-time feedback on energy use and costs.

**Electric Vehicle Charging Station**
Equipment that charges an electric vehicle. When connected to the home area network, it will allow a user to program settings through the internet to charge their car.

**Pool Pump**
When connected to the home area network, the pump can be controlled through the internet, allowing users to program settings remotely.



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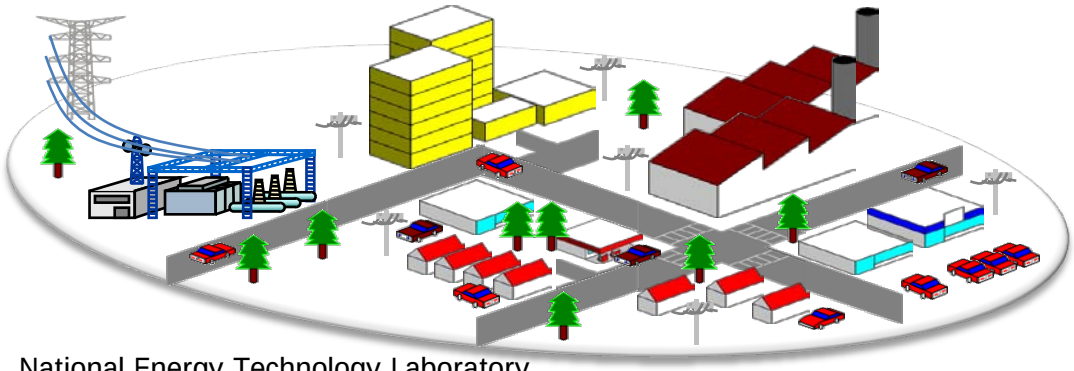
# Managing a Microgrid

**Distribution Management System**

**SCADA System**

**Grid Resources**
Capacitor Banks
Voltage Regulators
Automated Switches
Power Electronics
Communications



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# Managing a Microgrid

**Distribution Management System**

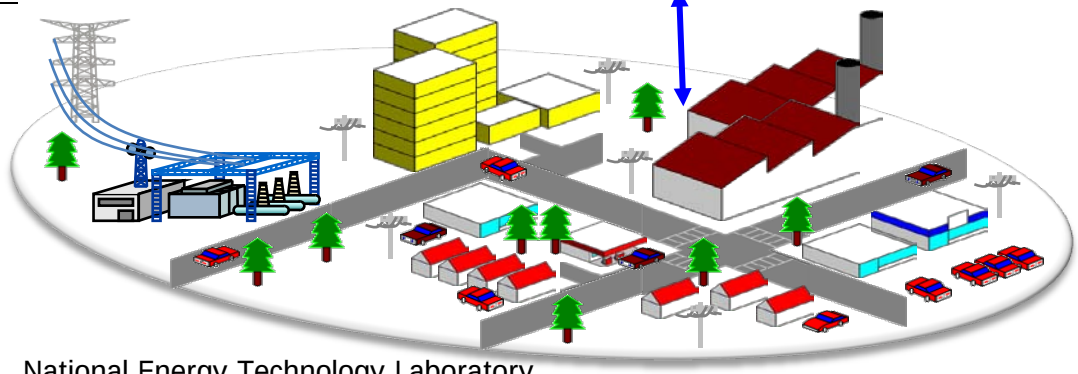
**SCADA System**

**PDLM**

**HAN System**

**Grid Resources**
Capacitor Banks
Voltage Regulators
Automated Switches
Power Electronics
Communications

**Distributed Energy Resources**
Substation Energy Storage
Community Energy Storage
Photovoltaic Systems
Micro-turbines
Fuel cells
Building Energy Storage
Home Energy System
PHEVs
Other Distributed Generation



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# Managing a Microgrid

**Information**
Community Objectives
DER configuration
Load and Resource Profiles
Electricity Pricing
Weather
Network status

Optimize the use of local resources to improve the power quality, reliability and operational efficiency of the microgrid.

**Distributed Energy Resources**
Substation Energy Storage
Community Energy Storage
Photovoltaic Systems
Micro-turbines
Fuel cells
Building Energy Storage
Home Energy System
PHEVs
Other Distributed Generation

Distribution Management System

Microgrid Controller

Monitor device status & request SCADA operations

SCADA System

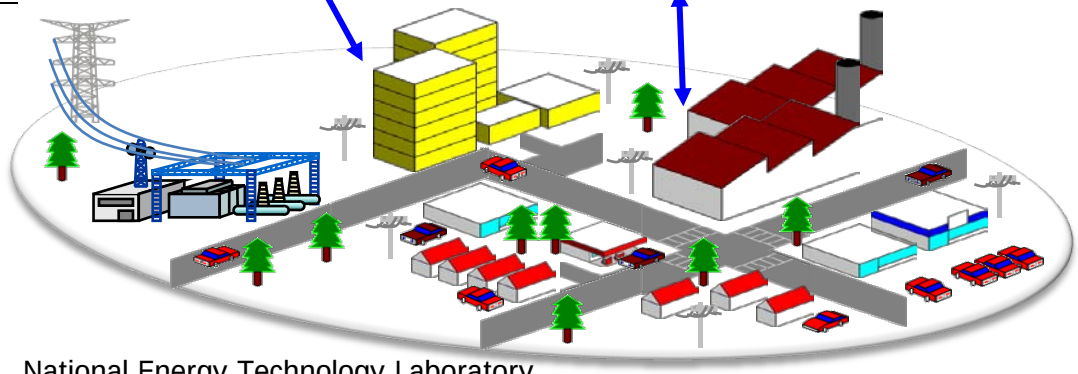
Monitor/request DR & provide price signals

PDLM

Monitor & control DER

**Grid Resources**
Capacitor Banks
Voltage Regulators
Automated Switches
Power Electronics
Communications

HAN System



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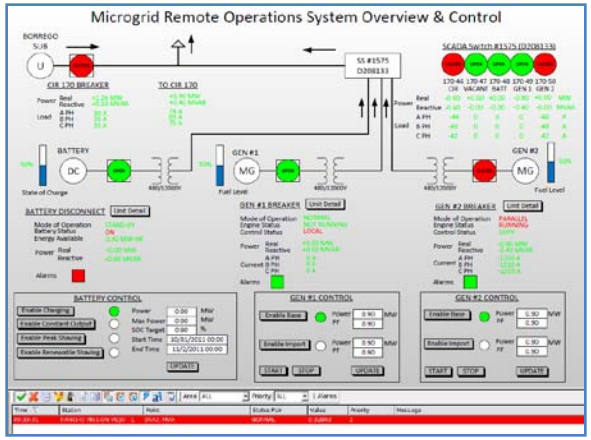
# Technical Accomplishments FY11

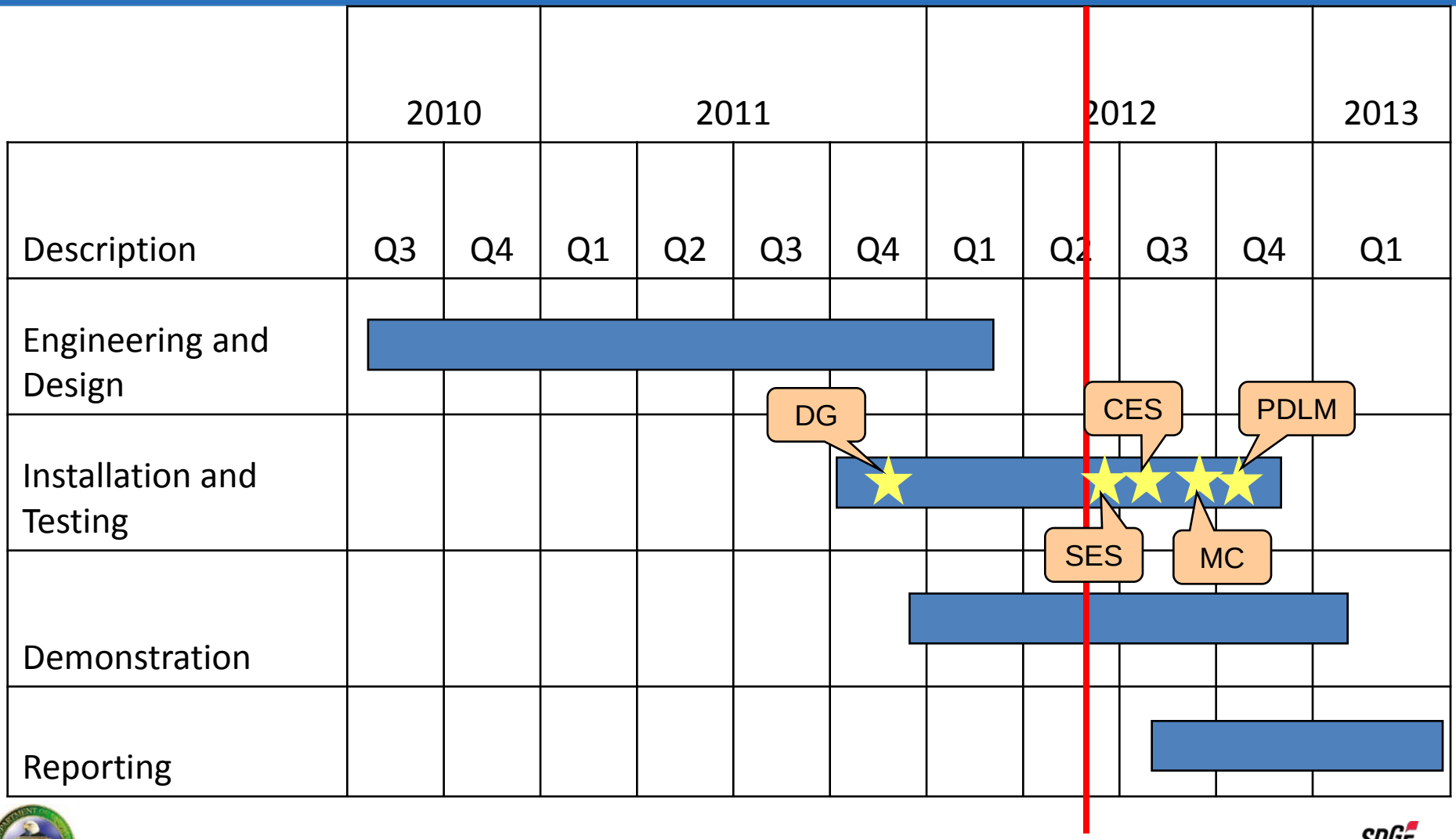
- ✓ Executed agreement to for the development, installation and integration of PDLM system, 11/11
- ✓ Conducted initial DG demonstrations, 11/11
- ✓ Executed agreement to procure one SES, 11/11
- ✓ Executed agreement to procure three CES
- ✓ DG Site Acceptance Test, 10/11
- ✓ DG Factory Acceptance Test, 9/11
- ✓ Collaborated on the development of microgrid controller, 6/11 – 12/11
- ✓ Conducted RFP for Advanced Energy Storage, 3/11 – 8/11
- ✓ Conducted RFP for Price-Driven Load Management, 3/11 – 7/11
- ✓ Obtained Authority to Construct from San Diego County APCD, 3/11

# Planned Technical Accomplishments FY12

- ✓ Obtained Stationary Source Permit from San Diego County APCD, 3/12
- ✓ Designed layout for SES, 3/12
- ✓ Conducted Factory Acceptance Test for SES, 6/12
- Conduct Factory Acceptance Test for CES, 7/11
- Conduct Site Acceptance Test for SES, 7/12
- Conduct Site Acceptance Test for CES, 8/12
- Go-Live with Microgrid Controller, 9/12
- Go-Live with Price-Driven Load Management, 10/12
- Conduct Feeder Optimization scenarios, Q4

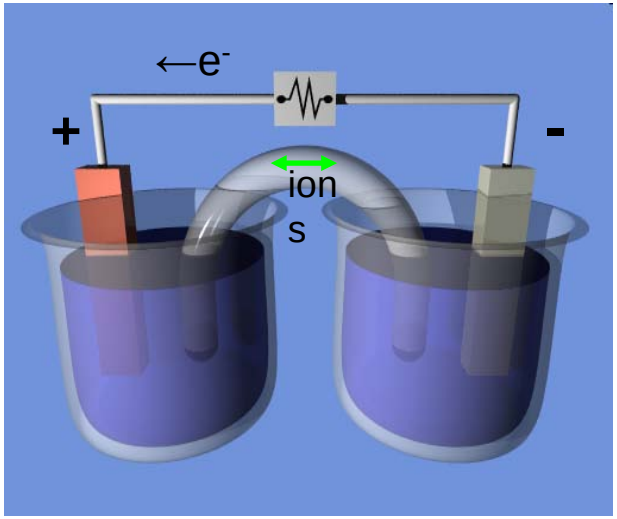


# High Level Project Schedule



# Challenges

- Permitting
- New technology
- Standards
- Security – Cyber and Physical
- Customer participation




# Significance and Impact

- First large scale utility microgrid
- Actually island real customers
- Alternative service delivery model
- Prove advanced technologies for future applications
- Establish model to be used by other utilities

# Project Partners

# Interactions & Collaborations

## Internal

- Billing
- Communications
- Demand Response Distribution Operations
- Distribution Planning
- Forecasting
- Grid Operations
- HAN
- Information Security
- Information Technology
- Legal
- Load Profiling
- Media
- Procurement
- Rates
- Research
- Smart Meter

## Partners

- Horizon Energy
- Lockheed Martin
- Oracle
- PNNL
- SAFT
- S&C Electric
- USD – EPIC
- Xanthus (CEC)

## Projects

- SDG&E Smart Grid Communications System (DOE/CEC)
- SDG&E Community Energy Storage (DOE)

## Sponsors

- US Department of Energy
- California Energy Commission

## Other External

- Accuvant – security
- CAISO
- City of Borrego Springs
- Control4
- NOAA
- Phazer
- Tendril
- Sunverge
- SwRI - security

# Recent Interactions

**Community Groups**

- 7th Annual SDG&E Energy Showcase, 5/11
- Energy Efficiency Thank You Celebration, 4/25
- Arbor Day (Borrego Springs), 4/20
- Energy Focus 2012, 4/14 4th Annual SDG&E Engineering & Technology Expo, 3/12
- SDG&E Excellence in Civic Leadership Kickoff Breakfast, 2/12
- Borrego Springs Community Sponsor Group, 12/11
- South Orange County Reliability Enhancement Project Open House, 11/11
- Borrego Days, 10/11
- Meet the Commissioner Event with CPUC Commissioner Cathy Sandoval, 10/11
- SDG&E Environmental Champions Initiative Kick-off, 8/11
- SDG&E Educational & Technical Seminar, “What is a microgrid?”, 6/11
- SDG&E Third Annual Engineering & Technology Expo, 5/11
- University of California at San Diego Green Open House, 4/11
- Borrego Springs Energy Fair, 4/11
- South Orange County Community Leaders Spotlight, 3/11
- Borrego Springs Sponsor Group meeting, 2/11

***Industry Groups***

- Delegation from China, 5/12
- State Grid Corporation of China, 11/11
- Electrical Storage Applications and Technologies Conference, 10/11
- DONG Energy, 9/11
- Project overview and tour for DOE representatives, 8/11

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# Acknowledgements

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# Contact Information

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